

## Body Composition and Optimal Health

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**ABSTRACT:** *According to the most recent statistics, over 97 million Americans are overweight, and this number is increasing every year. Overweight is the most common type of altered body composition and is associated with a high incidence of cardiovascular disease, metabolic syndrome, hypertension, and dyslipidemia. Data from the National Institutes of Health (NIH) indicate that these conditions alone account for over \$100 billion in healthcare expenses annually; an observation that led the NIH to develop an Expert Panel Report to promote clinical recognition of, and intervention for, altered body composition. Body composition can be assessed by many methods*

*that are inexpensive and easy to incorporate into a busy clinical practice. Therapeutic interventions using nutritional support in concert with exercise have shown success in establishing healthy body composition. Providing low glycemic index, soy protein-based medical foods with a spectrum of nutrients such as calcium, magnesium, vitamins D and K, and the methylation-support factors (e.g., folate, vitamin B<sub>12</sub>) may be particularly beneficial to nutritionally support healthy body composition. Healthy body composition is essential to optimizing health and minimizing the risk of many of the most prevalent chronic conditions and diseases seen in our society today.*

More than 60 million Americans have some form of cardiovascular disease (CVD), including hypertension, coronary heart disease, stroke, and congestive heart failure.<sup>1</sup> At least 2,600 people die each day from CVD, which is one death every 33 seconds, and hypertension, dyslipidemia, diabetes, and poor nutrition are some of the factors that contribute to this alarming statistic. Hypertension alone accounted for 32 million office visits to medical practitioners in 1999 and is associated with 5 deaths per 100,000 population.<sup>2</sup>

A central factor in all of these conditions is altered body composition. Altered body composition may result from increased fat deposition and/or loss of muscle mass leading to an increase in fat-to-lean body mass. Body composition may also be affected by a decrease in skeletal mass, which is prevalent in conditions such as osteoporosis. Lifestyle influences, such as poor diet and lack of exercise, are main contributing factors to developing altered body composition.<sup>3-6</sup> Aging is also associated with altered body composition.

The association of altered body composition with chronic health conditions is so strong that in 1995 the NIH convened an Expert Panel to develop clinical practice guidelines for primary care practitioners to encourage programs for improving body composition.<sup>7,8</sup> Based on their review of randomized controlled trials, the majority of which were conducted for a minimum of 4 months, the Panel concluded that nutrition and lifestyle are of critical importance in promoting healthy outcomes with patients.

### WHAT IS BODY COMPOSITION?

Body composition is a measure of the amount of body mass represented in adipose (fat), skeletal muscle, visceral

organs and residual tissue, skeleton (bone), and fluid. Overweight and obesity are sometimes used synonymously with altered body composition. Indeed, excess weight from adipose tissue is the most common type of altered body composition; however, body weight alone is not a definitive assessment for altered body composition. For example, extreme athletes can have weights outside of a healthy reference range, but their actual body compositions may be optimal. The elderly may have weights within a healthy range, but the composition of lean muscle and/or bone may be compromised, often with a relative increase in body fat. Therefore, in addition to actual weight, clinical measures of weight distribution are key parameters in assessing body composition.

Several clinical methodologies exist to estimate body composition, especially fat-to-lean mass. Many of these methods are simple to perform in a busy clinical practice, the most common of which are summarized below.

#### *Body Mass Index (BMI)*

The BMI is a clinically convenient, noninvasive approach to assess altered body composition. BMI is calculated by dividing weight in kilograms by height-squared in meters, although easy-to-use BMI charts are available. Individuals with a BMI of 25 to 29.9 are considered overweight, while individuals with a BMI of 30 or greater are considered obese.<sup>9</sup> BMI is significantly related to adiposity, and is linearly associated with disease risk, but explains only about a third of the variance in adiposity between individuals of the same weight.<sup>10</sup> BMI may not be accurate in assessing body composition for people who are very short, very tall, muscular, or who suffer from certain medical conditions that involve edema.<sup>10</sup> Including a measure of fat deposition (e.g., waist

circumference) can address these concerns and provide a more thorough indication of body composition.

### ***Waist Circumference and Waist-to-Hip Ratio (WHR)***

The distribution of fat is a key variable to consider in body composition. For instance, in individuals with identical BMIs, those with excess central, abdominal fat (i.e., apple shape) are at increased risk for developing CVD, hypertension, and diabetes than are those with fat distribution primarily in the hips and thighs (i.e., pear shape). The WHR is calculated by dividing the waist circumference by the hip circumference. A WHR greater than 1.0 for men and/or 0.8 for women is associated with substantially increased disease risk. Waist circumference greater than 35 inches in women and 40 inches in men is a risk factor for metabolic syndrome.<sup>11</sup> Therefore, waist circumference or WHR in conjunction with BMI provides a convenient assessment of body composition.

### ***Skin-Fold Thickness***

Skin-fold thickness is inexpensive and easy to perform, but requires calipers and is often quite variable unless performed in a consistent manner by a trained technician or clinician. Skin-fold thickness is less accurate in people with higher than average body fat than in those within a healthy range of body fat. Skin-fold thickness may be combined with a measurement of mid-arm muscle circumference to obtain an estimate of fat-to-lean mass ratio.

### ***Bioelectric Impedance Analysis (BIA)***

BIA is a rapid and noninvasive method of assessing body composition that uses electric signals at different frequencies, which are impeded variably by body water, fat, and fat-free mass. BIA is based on the assumption that a constant relationship exists between fat-free body mass and fluid, which generally holds true for healthy adults.<sup>12</sup> This assumption may not be correct during rapid weight loss or gain, or with some disease conditions, and BIA is significantly influenced by the amount of electrolyte-rich fluid present; therefore, it can be influenced by the hydration state of the individual. Research studies have shown that BIA correlates well with measurements obtained from other measures of body composition such as dual-energy X-ray absorptiometry (DXA) across a wide range of body fat levels in adults.<sup>12-15</sup>

## **THE HEALTH IMPLICATIONS OF ALTERED BODY COMPOSITION**

Altered body composition is associated with many diseases or conditions, including CVD, dyslipidemia, hypertension, metabolic syndrome, and hormonal imbalance (Figure 1). In 1995, the NIH convened an Expert Panel to use evidence-based methods to investigate the role of altered body composition in disease.<sup>7,8</sup> The Expert Panel concluded that all adults (18 years of age or older) with a BMI of 25 or greater and/or a waist circumference of greater than 35 inches

in women or 40 inches in men are at high risk for developing associated diseases including hypertension, high blood cholesterol, type 2 diabetes, CVD, and metabolic syndrome. Moreover, the Panel recommended lifestyle interventions, including nutrition/diet and exercise, as the primary clinical approach, and suggested pharmacotherapy be considered only when necessary. Because BMI significantly correlates with total body fat and is easily determined, the Panel based its recommendations on BMI. The Panel also recommended waist circumference to be included for determining abdominal fat content.

### ***Body Composition and Hypertension***

Hypertension is found in about 50% of individuals over age 55 in industrialized countries and its incidence increases with age.<sup>16</sup> Genetics plays a significant role in hypertension, with as much as 20% to 40% of blood pressure variations in the general population attributable to genetic factors.<sup>17</sup> The most significant contribution to hypertension, however, appears to be from altered body composition.<sup>6</sup> Prevalence of hypertension has been associated with fat distribution in some studies,<sup>5</sup> but other studies suggest it is affected by increased fat-to-lean mass independent of the distribution.<sup>4</sup> A study of people of African origin showed an increase of 1 mm Hg in systolic blood pressure was associated with a BMI increase of 1.7 (kg/m<sup>2</sup>) in men and 1.25 (kg/m<sup>2</sup>) in women.<sup>4</sup> The NIH Expert Panel reviewed over 76 published research articles on hypertension and concluded that weight loss produced by non-pharmacotherapeutic methods, such as nutrition and lifestyle modifications, effectively reduces blood pressure in overweight hypertensive and non-hypertensive patients.<sup>7</sup>

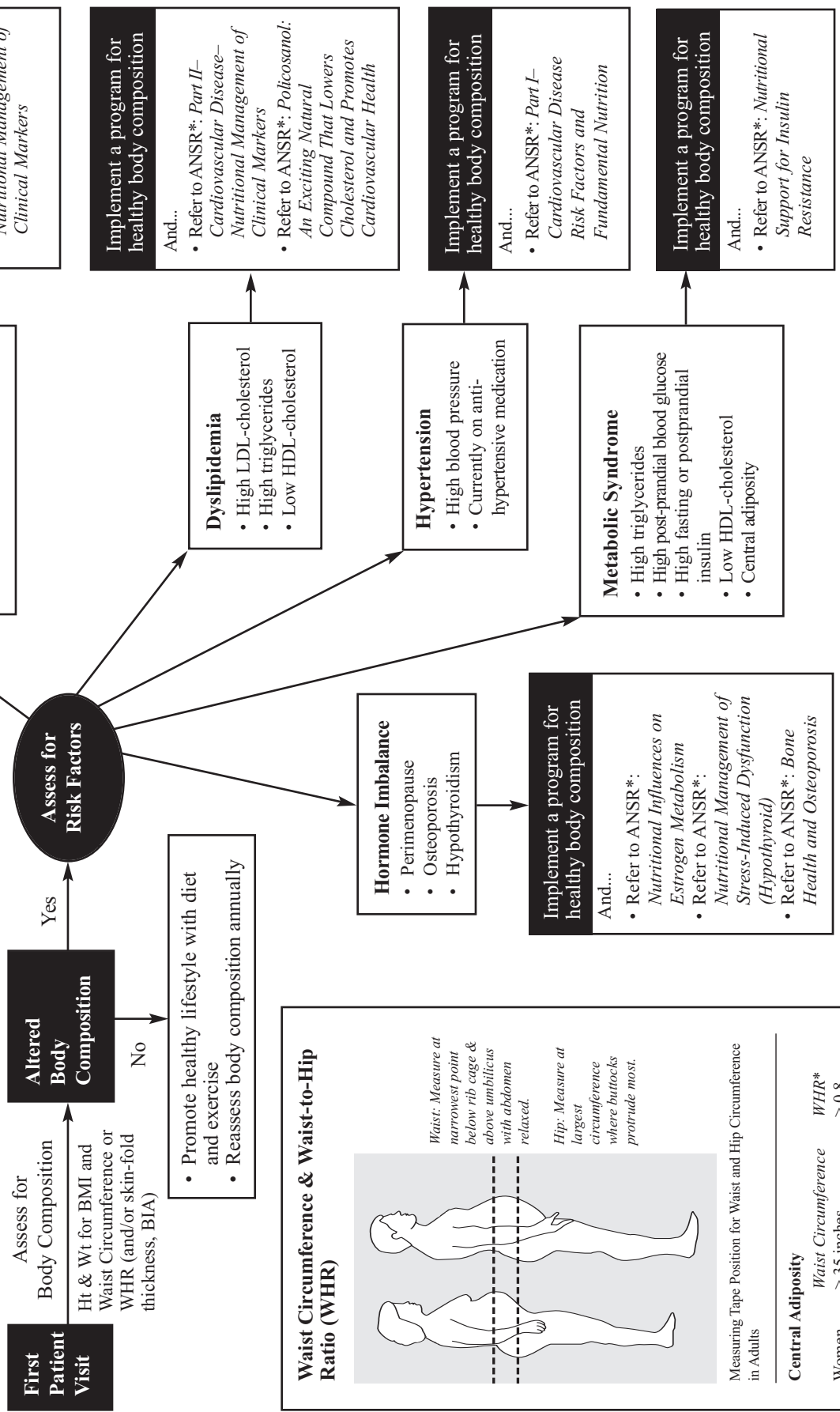
### ***Body Composition and Dyslipidemia***

A relationship between increased fat-to-lean mass and increased LDL-cholesterol, total cholesterol, and triglycerides has been well established for both men and women.<sup>18-21</sup> The pattern of fat distribution appears to affect blood lipid levels independent of body weight. In one study of 17,858 subjects, total cholesterol levels were higher in people with a WHR of 0.8 or greater for women and 1.0 or greater for men.<sup>18</sup> Central adiposity in children has also been shown to predict CVD risk, and children with high central adiposity have poorer lipid profiles than do their leaner counterparts.<sup>22</sup> After reviewing 65 randomized control trials, the NIH Expert Panel concluded that weight loss produced by non-pharmacotherapeutic approaches—including lifestyle and diet modifications—reduced serum triglycerides and LDL- and total cholesterol, and increased HDL-cholesterol. In contrast, the Panel found that weight loss produced by pharmacologic agents resulted in no consistent changes in blood lipids.<sup>7</sup>

### ***Body Composition and Metabolic Syndrome***

Metabolic syndrome (i.e., syndrome X) is characterized by a reduced rate of glucose disposal at a given insulin concentration. It is estimated that 25% or more of individuals

**Figure 1. Assessing Body Composition and Promoting Optimal Health for Your Patients**



**Waist Circumference & Waist-to-Hip Ratio (WHR)**

*Waist: Measure at narrowest point below rib cage & above umbilicus with abdomen relaxed.*

*Hip: Measure at largest circumference where buttocks protrude most.*

Measuring Tape Position for Waist and Hip Circumference in Adults

Central Adiposity	
Waist Circumference	WHR*
Women > 35 inches	> 0.8
Men > 40 inches	> 1.0

\* (WHR= Waist Circumference (in.)/Hip Circumference (in.))

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with metabolic syndrome will develop type 2 diabetes, and those at highest risk include first-degree relatives of diabetics, older women, and women with a history of gestational diabetes or polycystic ovary syndrome.<sup>23</sup> Those who do not develop diabetes are at risk for hypertension, stroke, and CVD. In fact, metabolic syndrome and its associated risk factors equals cigarette smoking as a contributor to premature CVD.<sup>11</sup> A recent review of metabolic syndrome can be found in the Applied Nutritional Science Report: *Nutritional Support for Insulin Resistance*.<sup>24</sup>

Metabolic syndrome is associated with obesity; however, it is clear that central adiposity is a more important determinant of metabolic syndrome than is body weight alone.<sup>23,25</sup> Therefore, even lean persons can have metabolic syndrome due to an accumulation of visceral adipose tissue. It is one of the most common conditions seen today; a 2002 study using data from 8,814 men and women over 20 years of age reported that 21.8% of men and 23.7% of women were found to have metabolic syndrome.<sup>26</sup> Moreover, its prevalence increased from approximately 7% of individuals between 20 and 29 years old, to around 43% of those over 60 years of age. Using 2000 census data, it is estimated that over 47 million U.S. residents have metabolic syndrome, which is defined as the presence of three or more of the following:

- waist circumference greater than 35 inches in women or 40 inches in men
- hypertriglyceridemia of 150 mg/dL (1.69 mmol/L) or greater
- low HDL cholesterol of <40 mg/dL in men or <50 mg/dL in women
- high blood pressure (above 130/85 mm Hg)
- high fasting glucose (above 110 mg/dL)

Based on an extensive review of the literature, the NIH Expert Panel concluded that weight loss produced by lifestyle modifications reduces blood glucose levels in overweight and obese persons without type 2 diabetes, and reduces blood glucose and HbA1c levels in some patients with type 2 diabetes.<sup>7</sup> Furthermore, the Panel found that weight loss produced by weight loss medications was no better than that from lifestyle modifications for improving blood glucose levels in overweight or obese persons both with and without type 2 diabetes.<sup>8</sup>

### ***Body Composition and Hormone Imbalance***

Changes in body composition are noted during aging, as are changes in hormone balance, and the relationship of these has been investigated in numerous research studies. In women, perimenopause and the menopause transition are associated with altered body composition, primarily by increased total and central fat and decreased skeletal and lean mass.<sup>27-30</sup> Menopause is also associated with adverse changes in blood lipids and with increased risk of CVD.<sup>31,32</sup> BMI is inversely correlated with premenopausal breast cancer risk but positively correlated with postmenopausal risk.<sup>28</sup> Women who gain significant weight in adulthood are also at higher risk of developing uterine (endometrial) cancer. HRT has been

used to reduce perimenopause symptoms and support postmenopausal maintenance of skeletal mass; however, its use is associated with a higher risk of breast cancer. Studies in which the effect of HRT on body composition have been examined are equivocal: some have shown HRT attenuates abdominal adiposity, while some have shown no effect of HRT on body composition or insulin-resistance.<sup>33</sup>

In men and postmenopausal women, estrogen is produced from testosterone by the enzyme aromatase, which is found in adipose tissue. Therefore, an increase in fat-to-lean mass should lead to an increase in circulating estradiol. In postmenopausal women not on HRT, circulating levels of all estrogen metabolites, as well as sex hormone binding globulin are significantly associated with BMI.<sup>34</sup> It has been hypothesized that this increased production of estradiol promotes central adiposity in both men and women as they age, resulting in the increased risk of CVD, stroke, hypertension, and metabolic syndrome.<sup>35</sup>

## **OBESITY**

Obesity is a chronic disease associated with many complications and comorbidities and several recent reviews of obesity are available.<sup>9, 36,37</sup> A recent review in the *New England Journal of Medicine* indicates that non-pharmacotherapeutic approaches to obesity should be considered as a first-line clinical strategy, and pharmacotherapeutic interventions should be considered only as adjunctive therapies.<sup>37</sup> Moreover, the NIH Expert Panel recommends pharmacotherapy for obesity only in patients with a BMI of 27 or greater with comorbid conditions such as hypertension; a BMI of 30 or greater; or in whom non-pharmacotherapeutic interventions have been unsuccessful.<sup>8</sup> Furthermore, the safety and efficacy of long-term (greater than 2 years) use of pharmacotherapeutic agents have not been established; therefore, long-term management of healthy body composition should not depend on pharmacotherapy.

## **CLINICAL MANAGEMENT OF HEALTHY BODY COMPOSITION**

An important part of a clinical management program for individuals who need to improve their body composition is providing adequate nutrition to support lean body mass, while appropriately limiting caloric intake. Many factors influence energy needs, including genetics and lifestyle, but a simple way to estimate daily energy expenditure with normal activities is to multiply weight (pounds) by 12 for men or 11 for women.<sup>9</sup> Loss of one pound of body fat per week requires that energy expenditure exceed intake by 3500 kcal/week or 500 kcal/day. For example, for a man weighing 200 pounds, loss of one pound/week would mean his daily caloric intake should be (12 x 200) - 500, which equals 1900 kcal/day. The addition of physical activity would allow a similar weight loss at a somewhat higher caloric intake.

The importance of providing adequate nutrition along with resistance exercise cannot be underestimated.<sup>38</sup> The low-

calorie diets commonly used alone in weight-loss programs may not be beneficial, and such diets may produce side effects of fatigue, dizziness, and weakness, and result in loss of lean body mass.<sup>10</sup> Since lean body mass increases energy needs, promotion of lean mass can allow a higher caloric expenditure, therefore decreasing the likelihood that fat mass will return after an intervention program. Enhanced lean body mass also supports increased physical activity and combats fatigue. Ongoing, regular physical activity has been shown to be a critical factor in preventing weight regain.

Ashley et al. recently investigated strategies for clinically successful weight management programs and found that adding meal replacements to traditional lifestyle intervention programs led to a more successful clinical outcome.<sup>39</sup> In fact, the use of meal replacements as part of the intervention resulted in patients maintaining a significantly greater weight loss over the year-long study, as compared to those patients who did not use a meal replacement during intervention. In other studies, the use of a micronutrient-fortified, soy-based medical food as a meal replacement in a weight management program has been shown to promote lean body mass with fat loss, whereas a non soy-based meal replacement led to loss of muscle mass.<sup>40,41</sup>

### SOY PROTEIN, ISOFLAVONES, AND HEALTHY BODY COMPOSITION

Soy protein has been extensively studied as a high-quality protein for promotion of healthy body composition and metabolism. Soy protein has a Protein Digestibility Corrected Amino Acid Score of 1.0, which is the highest score a protein can have.<sup>42</sup> Most notably, specific preparations of soy protein meal replacements have been shown to have beneficial effects on body composition<sup>40,41,43,44</sup> Perimenopausal women fed 40 grams of an isoflavone-containing soy protein meal replacement daily over 24 weeks showed increases in lean mass, whereas a control group consuming whey protein did not.<sup>40,41</sup> Research studies also indicate that consumption of soy protein may result in improvements in blood lipid levels and blood pressure.<sup>45-47</sup> Based on thorough review of the research literature, the FDA has issued a health claim stating that a daily consumption of 25 grams of soy protein as part of a diet low in saturated fat and cholesterol may reduce the risk of CVD.

Concern has been raised that soy consumption may adversely affect thyroid function. This issue arose prior to 1970, when a few cases of goiter in infants consuming soy-based infant formula were reported. At that time, infant formulas were not iodine-fortified. More recent data with iodine-supplemented infant formulas have not supported that soy itself has adverse effects on normal thyroid function. Moreover, studies fail to show clinically significant changes in thyroid function in either men or women who have normal thyroid function after consumption of soy. A few cases have suggested that soy may interfere with the uptake of levothyroxine when administered at the same time.<sup>48,49</sup> One *in vitro* study showed inhibition of thyroid peroxidase (TPO)-catalyzed reactions by isoflavones,

but this observation has not been reproduced *in vivo*.<sup>50</sup> Soy-based diets in iodine-deficient animals have been reported to lead to an increase in circulating thyroxine (T4) and TSH.<sup>51,52</sup> Therefore, although soy appears not to affect thyroid function in individuals with normal thyroid function, the effect on people with hypothyroidism is not yet clear.

### GLYCEMIC INDEX AND METABOLIC SYNDROME

Equal amounts of carbohydrates can have very different effects on blood glucose and insulin. The concept of the glycemic index (GI) has been developed to explain this observation. The GI determines blood glucose response to a food, and research documents that people at risk of diabetes, as well as those who have diabetes, should maintain a diet with low GI foods. Recent studies also suggest that a high dietary GI and high glycemic load in adults is associated with a low concentration of plasma HDL-cholesterol.<sup>53-55</sup> Therefore, the GI of a meal replacement is an important consideration in developing interventions for patients at risk of metabolic syndrome.<sup>24</sup> Recently, a soy-based medical food was shown to have a low GI, suggesting it could be a suitable component in a clinical intervention aimed at improving body composition while maintaining healthy blood glucose and insulin levels.<sup>56</sup>

The source of sweetener in any food should be considered, especially when designing a low GI diet. Fructose is a low GI, naturally occurring sweetener that is suggested as a preferred sugar source for diabetics.<sup>57</sup> Fructose is found in fruits, berries, and vegetables; for example, an apple contains between 15 to 20 grams of sugar, the majority of which is fructose.<sup>58</sup> A recent clinical trial has shown that ingestion of a large dose of fructose (50 grams) leads to only a modest increase in blood fructose, glucose or insulin, with no increase in blood glucose after ingestion of fructose at 15 grams or less.<sup>59</sup> Moore et al. have shown that a 7.5 gram dose of fructose attenuates the glucose peak after a 75 gram glucose load in healthy adults and in type 2 diabetics.<sup>60,61</sup>

### FIBER AND BMI

The Coronary Artery Risk Development in Young Adults (CARDIA) Study followed a cohort of more than 2,000 adults between the ages of 18 and 30 years for 10 years and, during this time, found that the individuals with the highest body weight showed higher blood lipids and blood pressure.<sup>62</sup> In this study, intake of dietary fiber was inversely associated with body weight and WHR. Fiber is known to promote healthy digestion, blood insulin, and blood glucose levels, as well as maintenance of healthy cholesterol levels.<sup>63,64</sup> Fiber is also associated with lower risk of CVD.<sup>65</sup> Fiber intake of 20 to 30 grams per day should be considered in the optimal dietary approach to promoting healthy body composition.<sup>24</sup>

### HOMOCYSTEINE AND ITS ASSOCIATION WITH ALTERED BODY COMPOSITION

Elevated blood homocysteine is associated with aging, obesity, and risk of CVD and insulin resistance. Since

homocysteine is an independent risk factor for CVD, it is an important factor to consider in individuals who may be at risk of CVD. Homocysteine is also associated with altered body composition. For instance, in a study of 65 men and 120 women between the ages of 67 and 78, 33% of the women and 66% of the men were found to have hyperhomocysteinemia.<sup>66</sup> A positive correlation was noted between homocysteinemia, age, and diastolic blood pressure with altered body composition in the women, and a direct correlation was observed between plasma homocysteine levels and BMI in the men. Gallistl et al. found that decreases in homocysteine correlated significantly with increases in lean body mass during weight reduction in obese children.<sup>67</sup> Folate and vitamin B<sub>12</sub> are key vitamins that promote reduction of hyperhomocysteinemia and support healthy homocysteine levels.

### CALCIUM, MAGNESIUM, AND POTASSIUM BALANCE

Calcium, potassium, and magnesium balance are important in maintenance of healthy body composition. In addition, they have been found to be beneficial in hypertension, a condition frequently associated with altered body composition. Although studies have suggested sodium restriction may be helpful in older persons, more recent data, including meta-analyses, suggest that adequate intakes of potassium and calcium, and possibly magnesium, are more important in maintaining healthy blood pressure.<sup>16,68</sup> The Dietary Approaches to Stop Hypertension (DASH) trial, which involved 459 subjects in 5 cohorts, investigated the effect of these micronutrients on blood pressure using diets that had consistent levels of sodium.<sup>69</sup> Relative to the control diet, the diet that provided at least 22 mg magnesium, 213 mg potassium, and 58 mg calcium per 100 kcal significantly reduced systolic blood pressure by 5.5 mm Hg and diastolic blood pressure by 3.0 mm Hg.<sup>70,71</sup>

While investigating the role of calcium on hypertension, Zemel et al. found calcium supplementation was also associated with reduced adiposity in many subjects.<sup>72</sup> Animal studies show that calcium can regulate adipocyte metabolism and energy storage, and data from several clinical trials have shown an association between calcium intake and a decrease of body fat.<sup>73-75</sup> These observations suggest that calcium may attenuate disease risk and promote healthy body composition by several mechanisms.

### BONE MINERALIZATION, BODY COMPOSITION, AND NUTRITURE

Throughout life, skeletal mass and lean muscle mass are related, and loss of bone density is common after 40 years of age; by 80 years of age men have an average reduction of 12% and women of 25% in bone density (osteoporosis).<sup>3</sup> Major factors influencing bone density are adequate intake of bone-support nutrients and weight-bearing exercise to

promote growth of new or replacement tissues.<sup>30,76</sup> Nutrients that support bone mass include calcium, magnesium, phosphorus, and vitamins D and K.<sup>77,78</sup> An adequate level of dietary calcium is particularly important since calcium absorption efficiency often decreases in women after 40 years of age.<sup>79,80</sup> Studies also suggest the RDA for calcium may be too low for people under age 30, when skeletal acquisition is still occurring. Calcium supplementation has been shown to slow or even prevent bone loss.<sup>78</sup>

Phosphorus comprises about half the weight of bone mineral and is also important to consume, but phosphorus and calcium must be in balance since a high level of phosphorus can depress calcium mineralization.<sup>77</sup> Low magnesium may influence both matrix and mineral deposition in bone, causing cessation of bone growth, osteopenia, and bone fragility.<sup>81</sup> Magnesium supplementation is associated with increased bone mineral density. Vitamin D has long been known to support mineral absorption and bone formation and serum vitamin D levels are associated with osteoporosis.<sup>78</sup> Vitamin K is primarily dependent on dietary sources and low serum levels are associated with decreased bone mass and increased prevalence of fractures.<sup>82</sup> Supplementation with vitamin K has been shown to reduce urinary calcium loss, decrease urine markers for bone resorption, and increase serum markers of bone formation.<sup>79</sup>

Finally, studies suggest that soy protein supports bone health. Arjmandi et al. used an ovariectomized rat model for osteoporosis and found that soy-fed animals had significantly greater bone densities in vertebral and femoral bone than did a non-soy fed control group.<sup>83</sup> Most interest has focused on the role of soy isoflavones in bone health and Scheiber and Rebar<sup>84</sup> have recently reviewed the status of this research. Although the data on long-term studies are limited at this time, isoflavones appear to reduce the bone resorption often seen during and after menopause.

### CONCLUSION

The incidence of CVD, hypertension, dyslipidemia, metabolic syndrome, and diabetes in our society is alarming. A central factor in all of these conditions is altered body composition, primarily that which occurs from an increase in the ratio of fat-to-lean body mass. Aging, in particular, is associated with a decline in lean muscle mass and an increase in fat mass. Environmental influences, including poor diet and lack of exercise, contribute to altered body composition; however, clinical intervention with targeted nutritional support for reestablishing and maintaining a healthy body composition can play a key role in promoting optimal health for patients. Soy-based medical foods designed to nutritionally support healthy body composition provide a useful tool to the clinician in developing successful strategies for rebalancing an unhealthy lifestyle to one that is more beneficial for the development of a healthy body composition.

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# Body Composition and Optimal Health: A Summary

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More than 60 million Americans have some form of cardiovascular disease (CVD), and more than 2,600 people die from CVD each day.<sup>1</sup> Hypertension is found in about 50% of individuals above 55 years.<sup>2,16</sup> Metabolic syndrome—characterized by elevated blood glucose and insulin responses—is one of the most common conditions seen today and is estimated to be present in about 22% of men and 24% of women.<sup>26</sup> A central factor in all of these conditions is altered body composition. **Adults with altered body composition are at high risk for developing:**<sup>7,8</sup>

- Cardiovascular disease (CVD)
- High blood pressure
- Dyslipidemias such as high blood cholesterol
- Metabolic syndrome
- Type 2 diabetes

## WHAT IS ALTERED BODY COMPOSITION?

Body composition is a measure of the amount of body mass (weight) that is present as fat, bone, and lean muscle.<sup>3-6</sup> **Altered body composition may occur from increased fat and/or loss of lean muscle, which result in an increase of fat-to-lean body mass.** Although the most common form of altered body composition is from excess fat, decreased skeletal mass by loss of bone, such as seen with osteoporosis, is also a form of altered body composition. Body composition can be determined by:

- **Body Mass Index (BMI):** BMI is calculated from weight and height or can be obtained from an easy-to-use chart. Individuals with a BMI of 25 to 29.9 are considered overweight, while individuals with a BMI of 30 or greater are considered obese.<sup>9-11</sup>
- **Waist Circumference or Waist-to-Hip Ratio (WHR):** People who accumulate fat in the abdominal area (apple-shaped body) are at a significantly increased risk for developing diseases as compared to those with fat accumulation primarily in the hips and thighs (pear-shaped body).<sup>7,8,11,24</sup> A waist circumference greater than 35 inches for women or 40 inches for men, or a WHR of 0.8 or greater in women, or 1.0 or greater in men indicates abdominal adiposity.
- **Bioelectric Impedance Analysis (BIA):** BIA uses electric signals at different frequencies, which are impeded (slowed down) differently depending on whether they are moving through fat or lean muscle mass.<sup>12</sup>

## HOW CAN I SUPPORT HEALTHY BODY COMPOSITION?

**An important part of a clinical management program to improve body composition is adequate nutrition to support lean body mass, while appropriately limiting caloric intake.** The low-calorie diets commonly used in weight-loss programs may not be beneficial, and such diets may produce side effects of fatigue, dizziness, and weakness, and result in loss of lean muscle mass.<sup>10</sup> **Research has shown that clinical programs that include a supplemental meal replacement are more successful for weight loss.**<sup>33</sup> Interventions for healthy body composition should always include resistance exercise as well, since increasing muscle mass increases energy needs, helps combat fatigue, and decreases the likelihood that fat mass will return after the program is completed.<sup>38</sup>

### *Soy Protein, Isoflavones, and Healthy Body Composition*

Soy protein is a high-quality protein source that may improve blood pressure and blood lipids.<sup>45-47</sup> Based on a thorough review of the research literature, **the FDA has issued a health claim stating that a daily consumption of 25 grams of soy protein as part of a diet low in saturated fat and cholesterol may reduce the risk of CVD.**

Specific preparations of soy protein have also been shown to promote healthy body composition. **For example, a soy-based medical food has been shown to promote lean body mass over a non-soy based meal replacement in a weight management program.**<sup>40,41</sup> **And, perimenopausal women fed 40 grams of an isoflavone-containing soy protein daily for 24 weeks showed increases in lean mass, whereas a control group consuming whey protein did not.**<sup>43,44</sup>

### *Glycemic Index (GI), Fructose, and Metabolic Syndrome*

The GI assesses blood glucose response to a food, and research documents that people at risk of diabetes should maintain a diet with low GI foods.<sup>24,53-55</sup> **Recently, a soy-based medical food was shown to have a low GI, suggesting it could be a suitable source of protein and nutrients while maintaining healthy blood glucose and insulin levels.**<sup>56</sup>

The source of sweetener in any food should be considered as well, and fructose is a low GI, naturally occurring sweetener. **Fructose is suggested as a preferred sugar source for diabetics since large doses of fructose (50 grams) only modestly raise blood sugar or insulin levels, and small doses show virtually no effect on blood sugar or insulin.**<sup>57-61</sup>

### *Fiber and BMI*

Fiber is known to promote healthy digestion, blood insulin, and blood glucose levels, as well as maintenance of healthy cholesterol levels; and, **fiber is associated with lower risk of CVD.**<sup>63-65</sup> In the 10-year-long CARDIA Study of more than 2,000 adults, those individuals with the highest intake of fiber had the lowest body weight and WHR, and those with the highest body weight showed higher blood lipids and blood pressure.<sup>62</sup> **Fiber intake of 20 to 30 grams per day should be considered in the optimal diet for promoting healthy body composition.**<sup>24</sup>

### *Homocysteine, Folate, Vitamin B<sub>12</sub>, and Optimal Health*

Elevated blood homocysteine is associated with aging and obesity, and is an independent risk factor for CVD. Research also shows that it is associated with altered body composition in both adults and children.<sup>66,67</sup> **Folate and vitamin B<sub>12</sub> are key vitamins that promote reduction of homocysteine levels.**

### *Calcium, Magnesium, and Potassium Balance*

Early studies suggested restricting sodium may be helpful in older persons, but more recent data—including those from the large, multicenter Dietary Approaches to Stop Hypertension (DASH) trial—suggest calcium, potassium, and magnesium are more important in maintaining healthy blood pressure.<sup>16,68-71</sup> **Low intake of calcium is also associated with higher levels of body fat, and calcium supplementation has been shown to promote healthy body composition and decrease fat retention in clinical trials and animal studies.**<sup>72-75</sup>

## BONE HEALTH AND BODY COMPOSITION

Throughout life, skeletal and lean muscle masses are related. Bone density decreases dramatically after the age of 40, so that by 80 years of age, men have lost on average 12% and women 25% of bone.<sup>3</sup> Major factors in bone health are adequate intake of bone-support nutrients, and weight-bearing exercise to promote new bone growth.<sup>30,77,78</sup>

**Calcium supplementation has been shown to slow or even prevent bone loss in older individuals.**<sup>77</sup> About half the weight of bone mineral is from phosphorus, and **it is important that intake of phosphorus and calcium be in balance.**<sup>77</sup> Low magnesium, vitamin D, and vitamin K levels are associated with decreased bone mass and increased prevalence of fractures.<sup>78,81,82</sup> **Supplementation with these nutrients is important in promoting bone density.**<sup>78,79</sup> In addition, **research suggests that soy with isoflavones reduces the bone resorption often seen during and after menopause.**<sup>83,84</sup>